

AMRF-C POWER SHELTER SPECIFICATIONS:

**The contractor must provide a power shelter meeting the following requirements of this specification:**

TABLE OF CONTENTS:

Appendix A Power Shelter Definition

Section 16365 Power Shelter

Appendix B Associated Electrical Specifications

- Section 16050N Basic Electrical Material and Methods
- Section 16081N Apparatus Inspection and Testing
- Section 16120A Insulated Wire and Cable
- Section 16402N Interior Distribution System.....

Appendix C General Requirements

Section 01781N Operation and Maintenance Data

Appendix D

Drawings

Note:

This procurement must include both female and male sides of all external connectors. No external wire is assumed to be included with this part.

## Appendix A

### SECTION 16365

#### POWER SHELTER

The contractor must provide a power shelter meeting the following requirements:

#### PART 1 GENERAL

Not Used.

#### PART 2 PRODUCTS

##### 2.1 POWER SHELTER CONSTRUCTION

NEMA 3R structure with exterior walls and roof fabricated from self-framing interlocking panels to house and protect the internal equipment from the elements. Structural grid base and floor designed for applicable floor loading allowing the Equipment Center to be lifted and transported with the interior equipment installed.

##### 2.1.1 Nominal Dimensions

16.25 feet long (outside walls)  
7.00 feet wide (outside walls)  
7.67 ceiling height

##### 2.1.2 Piece #1 Estimated Shipping Dimensions

30.00 length feet  
7.50 width feet  
9.46 height feet  
14,625 empty weight lbs.  
16,000 equipment weight lbs.  
30,625 total weight Piece #1 lbs.

##### 2.2 DESIGN

Location - Washington, DC, other  
Area Classification - General purpose non-hazardous  
30 Roof Load - Uniform Building Code 1997 in psf  
80 Wind Load - Uniform Building Code 1997 in mph, Exposure C minimum  
250 Floor Loading - DL + LL in psf  
Base Deflection - L/240 (on foundation)  
2A Seismic Zone - Uniform Building Code 1997, Importance Factor = 1)  
30 Lighting Level - at floor in footcandles

## 2.2.1 HVAC Design Information

- a. Interior Design Information.
  - (1.) 55 degrees F minimum.
  - (2.) 105 degrees F maximum.
- b. Exterior Design Information.
  - (1.) 10 degrees F minimum.
  - (2.) 95 degrees F maximum.

## 2.3 MATERIALS

### 2.3.1 Configuration

- a. (Single width) Structural steel base fabricated from ASTM A36 channel, wide flange & angle sections forming a self-supporting grid with 1/4" steel floor plate.
- b. 1 inches of Isofoam S1438-018 spray foam insulation (R7.7/inch thick, flame spread rating 25).
- c. Exterior walls of 18 ga. pre-galvanized G90 sheet steel interlocking panels.
- d. Roof panels of 18 ga. pre-galvanized G90 sheet steel interlocking panels.
- e. Ceiling panels of 18 ga. pre-galvanized G90 sheet steel interlocking panels w/R11 fiberglass bat insulation.
- f. Interior walls: 18 ga. pre-galvanized G90 wall panels w/R11 insulation.

## 2.4 DOORS

### 2.4.1 Galvanized Personnel Doors

#### 1 #3070 Galvanized Personnel Door.

- a. 18 ga. galvanized 1-3/4" thick UL listed, R4.17, 1.5 hour fire rating.
- b. Weather strip (807A-3070).
- c. Closer w/stopping arm (Yale series #50, 154AL).
- d. Crash chain (15F2C).

- e. Stainless steel hinges (THB 20 4.5 x 4.5 32D).
- f. Aluminum threshold (LT245HV-36).
- g. Drip shield.
- h. Sign "Danger High Voltage/Keep Out (Ideal #44-880).
- i. Factory frame (MSR 3070 R/L 3" galvanized).

1 #4080 Galvanized Personnel Door.

- a. 18 ga. galvanized 1-3/4" thick UL listed, R4.17, 1.5 hour fire rating.
- b. Weather strip (807A-4080).
- c. Closer w/stopping arm (Yale series #50, 154AL).
- d. Crash chain (15F2C).
- e. Stainless steel hinges (THB 20 4.5 x 4.5 32D).
- f. Aluminum threshold (LT245HV-48).
- g. Drip shield (MSI #).
- h. Sign "Danger High Voltage/Keep Out (Ideal #44-880).
- i. Factory frame (MSI 4080 R/L 3" galvanized).
- j. Aluminum Button type panic hardware (Magnokrom #N1550-5XOT53X27) with cylinder lock.

2.5 FINISH

2.5.1 Colors

- a. Exterior Color - White.
- b. Interior Color - White.
- c. Floor Color - White

## 2.5.2 Standard Duty Paint System

Exterior surfaces - walls, roof & fascia substrate: G90 galvanized material.

- a. Clean all surfaces to SSPC-SP1 (solvent cleaning).
- b. Primer - Kern Aqua wash primer (E61G520) .5 mils DFT.
- c. Intermediate - 2.8 VOC catalyzed epoxy primer (E61/V93VY9) 1.5 mils DFT. (Brand name or equal)
- d. Finish - High solids polyurethane enamel (Polane Plus F63/V66V55) 1 mils DFT. (Brand name or equal)
- e. Touchup paint - (1) quart (ships inside Equipment Center).

Interior surfaces - substrate: G90 galvanized material.

- a. Clean all surfaces to SSPC-SP1 (solvent cleaning).
- b. Primer - Kern Aqua wash primer (E61G520) .5 mils DFT. (Brand name or equal)
- c. Intermediate - 2.8 VOC catalyzed epoxy primer (E61/V93VY9) 1.5 mils DFT.
- d. Finish - High solids polyurethane enamel (Polane Plus F63/V66V55) 1 mils DFT. (Brand name or equal)
- e. Touchup paint - (1) quart (ships inside Equipment Center).

Floor - (Top Area).

- a. Clean all surfaces to SSPC-SP1 (solvent cleaning).
- b. Primer - 2.8 VOC catalyzed epoxy primer (E61/V93VY9) 3 mils DFT.
- c. Finish - High solids polyurethane enamel (Polane Plus F63/V66V55) (Brand name or equal)  
1 mils DFT with non-skid additive.
- d. Touchup paint - (1) quart (ships inside Equipment Center).

Base & Floor Underside

- a. Clean all surfaces to SSPC-SP3 (power tool cleaning).

b. Cleaned to remove oil, dirt, water and loose rust.

c. Undercoat - Carboline 954 epoxy 6-8 mils DFT.

## 2.6 ELECTRICAL UTILITIES

Lot of exposed EMT conduit for following furnished items as required by NEC (3/4" diameter minimum), ANSI C80.3.

a. Wire.

(1.) Power wiring - Type THHN #12AWG stranded minimum.

(2.) HVAC controls - #18 AWG thermostat cable.

b. 3 Fluorescent interior lights.

(1.) 4' x 2 lamp x 34W.

(2.) Wraparound, surface mount (Metalux W240A120VLE3).

c. 2 Switch/receptacle combination.

(1.) Light switch - 20A, specification grade, 1-way, Leviton #CS120-21 (1661).

(2.) Duplex receptacle - 125V GFCI, 20A., ivory, specification grade (Leviton #6899-1) (1647)

d. 12 30A, 600V, 3W-4P exterior receptacles.

e. 7 60A, 600V, 3W-4P exterior receptacles.

f. 3 200A, 600V, 3W-4P exterior receptacles.

g. 19 additional circuit/conduit runs at 5A-100A.

h. 3 additional circuit/conduit runs at 200A.

## 2.7 GROUNDING

a. 2 Ground pads - 2 hole with 1 ground lug each @ base (T&B #32211-4/0).

## 2.8 HVAC EQUIPMENT

Bard Manufacturing Company, 3 phase, 480V air conditioner units. (Brand name or equal)

a. Bard Mfg. Co. air conditioner model #WA701-C09BPXXXJ - 6 ton wall mount with 9KW heat, 480V, 3 phase (25A breaker). (Brand name or equal)

b. Bard standard accessory package. Totaline SX100 thermostat P274-0100, auto changeover, digital, F or C display. "J" package controls

(1.) Low pressure switch

(2.) High pressure switch

(3.) Low ambient control

(4.) Compressor anti-cycle relay

(5.) Alarm relay

c. Blank-off plate.

d. Supply & return grills.

e. Pleated filter 2".

## 2.9 EQUIPMENT

### 2.9.1 Equipment

a. Shipping units of 480V switchgear.

b. Shipping units of 5KV switchgear.

### 2.9.2 Transformers

a. 2 transformers 150KVA.

b. 1 transformer 300KVA.

c. 1 transformer 750/1000KVA cast transformer.

### 2.9.3 Distribution Panels

a. 2 AC panelboards, 3 phase, 4 wire, 208Y/120V, 225A, 42 circuit, 10KAIC, bolt-in breakers.

b. 1 SQD MPZ 30KVA, 480-208Y/120V transformer/load center, 3 phase, 4 wire.

## 2.10 ACCESSORIES

Lot of removable lift lugs at base are required. (Note: Due to shipping considerations, these items ship loose with the building).

- a. 4 floor cutout with removable 12 ga. galvanized cover.
- b. 22 wall cutout (small) with removable 11 ga. galvanized bulkhead ( $\leq 12\text{wx}24\text{h}$ ).
- c. 5 wall cutout (large) with removable 11 ga. galvanized bulkhead ( $>12\text{wx}24\text{h}$ ).
- d. 1 platform "A" - galvanized, serrated grating walking surface and supports. (Note: Due to shipping considerations, these items ship loose with the building.)
  - (1.) 3 width in feet.
  - (2.) 7 length in feet (long side).
- e. 1 platform "B" - galvanized, serrated grating walking surface and supports. (Note: Due to shipping considerations, these items ship loose with the building.)
  - (1.) 11.75 width in feet.
  - (2.) 7 length in feet (long side).
- f. 1 stand offs and barrier.

## 2.11 NOTES

- a. Enclosure must not carry the UL label.
- b. Spreader bars, cables and other lifting equipment must not be included unless noted otherwise.
- c. When handling and moving Equipment Center, all lift lugs must be used.
- d. Equipment Center must be supported at all times at all removable lift lug locations.



## **Appendix B**

### SECTION 16050N

#### BASIC ELECTRICAL MATERIALS AND METHODS

#### PART 1 GENERAL

##### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D709 (2000) Laminated Thermosetting Materials  
CODE OF FEDERAL REGULATIONS (CFR) 29 CFR 1910.147 Control of Hazardous Energy (Lock Out/Tag Out)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. (IEEE)

IEEE 100 (1996) Dictionary of Electrical and Electronics Terms (ANSI/IEEE)

IEEE C2 (1997) National Electrical Safety Code (ANSI/IEEE)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA C57.12.28 (1999) Pad-Mounted Equipment – Enclosure Integrity (Revision of ANSI C57.12.28-88)

NEMA ICS 6 (1993) Industrial Control and Systems Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1999) National Electrical Code

##### 1.2 RELATED REQUIREMENTS

This section applies to all sections of Division 16, "Electrical," of this project specification unless specified otherwise in the individual sections.

### 1.3 DEFINITIONS

- a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, must be as defined in IEEE 100.
- b. The technical sections referred to herein are those specification sections that describe products, installation procedures, and equipment operations and that refer to this section for detailed description of submittal types.
- c. The technical paragraphs referred to herein are those paragraphs in PART 2 - EXECUTION of the technical sections that describe products, systems, installation procedures, equipment, and test methods.

### 1.4 ELECTRICAL CHARACTERISTICS

Electrical characteristics for this project must be 4.16 kV primary, three phase, three wire, 60 Hz, and 480/277 volts secondary, three phase, four wire. Final connections to the power distribution system at the existing manhole must be made by the Contractor as directed by the Contracting Officer.

### 1.5 SUBMITTALS

Submittals must include the manufacturer's name, trade name, place of manufacture, catalog model or number, nameplate data, size, layout dimensions, capacity, project specification and technical paragraph reference. Submittals must also include applicable federal, military, industry, and technical society publication references, and years of satisfactory service, and other information necessary to establish contract compliance of each item to be provided. Photographs of existing installations are unacceptable and will be returned without approval.

#### 1.5.1 Manufacturer's Catalog Data

Submittals for each manufactured item must be current manufacturer's descriptive literature of cataloged products, equipment drawings, diagrams, performance and characteristic curves, and catalog cuts. Handwritten and typed modifications and other notations not part of the manufacturer's preprinted data will result in the rejection of the submittal. Should manufacturer's data require supplemental information for clarification, the supplemental information must be submitted as specified for certificates of compliance.

#### 1.5.2 Drawings

Submit drawings a minimum of 14 by 20 inches in size using a minimum scale of 1/8 inch per foot, except as specified otherwise. Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams must identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings must indicate

adequate clearance for operation, maintenance, and replacement of operating equipment devices.

### 1.5.3 Operation and Maintenance Manuals

Comply with the requirements of Section 01781N, "Operation and Maintenance Data" and the technical sections.

#### 1.5.5.1 Operating Instructions

Submit text of posted operating instructions for each system and principal item of equipment as specified in the technical sections.

## 1.6 QUALITY ASSURANCE

### 1.6.1 Material and Equipment Qualifications

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products, which are of equal material, design and workmanship. Products must have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period must include applications of equipment and materials under similar circumstances and of similar size. The product must have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in the technical section.

### 1.6.2 Regulatory Requirements

Equipment, materials, installation, and workmanship must be in accordance with the mandatory and advisory provisions of NFPA 70.

### 1.6.3 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

### 1.6.4 Service Support

The equipment items must be supported by service organizations, which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

#### 1.6.5 Manufacturer's Nameplate

Each item of equipment must have a nameplate bearing the manufacturer' name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

#### 1.6.6 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer.

#### 1.6.7 Material and Equipment Manufacturing Date

Products manufactured more than 1 year prior to date of delivery to site must not be used, unless specified otherwise.

### 1.7 POSTED OPERATING INSTRUCTIONS

Provide for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The operating instructions must include the following:

- a. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
- b. Start up, proper adjustment, operating, lubrication, and shutdown procedures.
- c. Safety precautions.
- d. The procedure in the event of equipment failure.
- e. Other items of instruction as recommended by the manufacturer of each system or item of equipment.

Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Operating instructions must not fade when exposed to sunlight and must be secured to prevent easy removal or peeling.

### 1.8 NAMEPLATES

ASTM D709. Provide laminated plastic nameplates for each panelboard, equipment enclosure, relay, switch, and device; as specified in the technical sections or as indicated on the

drawings. Each nameplate inscription must identify the function and, when applicable, the position. Nameplates must be melamine plastic, 0.125 inch thick, white with black center core. Surface must be matte finish. Corners must be square. Accurately align lettering and engrave into the core. Minimum size of nameplates must be one by 2.5 inches. Lettering must be a minimum of 0.25 inch high normal block style.

## 1.9 WARNING SIGNS

Provide warning signs for the enclosures of electrical equipment including substations, pad-mounted transformers, pad-mounted switches, generators, and switchgear having a nominal rating exceeding 600 volts.

- a. When the enclosure integrity of such equipment is specified to be in accordance with NEMA C57.12.28, such as for pad-mounted transformers, provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Sign must be a decal and must have nominal dimensions of 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 2 inch high letters. The word "DANGER" must be in white letters on a red background and the words "HIGH VOLTAGE" must be in black letters on a white background. Decal must be Panduit No. PPS0710D72 or approved equal.

## 1.10 CABLE TAGS IN HANDHOLES

Provide tags for each cable or wire located in handholes. Tag only new wire and cable provided by this contract. The tags must be polyethylene. Do not provide handwritten letters. As an example, a tag could have the following designation: "11.5 NAS 1-8(Phase A)500," denoting that the tagged cable is on the 11.5kV system circuit number NAS 1-8, underground, Phase A, sized at 500 kcmil.

### 1.10.1 Polyethylene Cable Tags

Provide tags of polyethylene that have an average tensile strength of 3250 pounds per square inch; and that are 0.08 inch thick (minimum), non-corrosive non-conductive; resistive to acids, alkalis, organic solvents, and salt water; and distortion resistant to 170 degrees F. Provide 0.05 inch (minimum) thick black polyethylene tag holder. Provide a one-piece nylon, self-locking tie at each end of the cable tag. Ties must have a minimum loop tensile strength of 175 pounds. The cable tags must have black block letters, numbers, and symbols one inch high on a yellow background. Letters, numbers, and symbols must not fall off or change positions regardless of the cable tags' orientation.

## 1.11 ELECTRICAL REQUIREMENTS

Electrical installations must conform to IEEE C2, NFPA 70, and requirements specified herein.

### 1.11.1 Motors and Equipment

Provide motors, controllers, integral disconnects, and contactors with their respective pieces of equipment. Motors, controllers, integral disconnects, and contactors must conform to Section 16365, "Power Shelter". Extended voltage range motors must not be permitted. Control voltage for controllers and contactors must not exceed 120 volts nominal. When motors and equipment furnished are larger than sizes indicated, the cost of additional electrical service and related work must be included under the section that specified that motor or equipment. Where fuse protection is specifically recommended by the equipment manufacturer, provide fused switches in lieu of non-fused switches indicated.

### 1.11.2 Wiring and Conduit

Provide internal wiring for components of packaged equipment as an integral part of the equipment. Provide power wiring and conduit for field-installed equipment under Section 16402N, "Interior Distribution System." Power wiring and conduit must conform to Section 16402N, "Interior Distribution System." Control wiring and conduit must be provided under, and conform to the requirements of the section specifying the associated equipment.

## 1.12 INSTRUCTION TO GOVERNMENT PERSONNEL

Where specified in the technical sections, furnish the services of competent instructors to give full instruction to designated Government personnel in the adjustment, operation, and maintenance of the specified systems and equipment, including pertinent safety requirements as required. Instructors must be thoroughly familiar with all parts of the installation and must be trained in operating theory as well as practical operation and maintenance work. Instruction must be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished must be as specified in the individual section.

## 1.13 LOCKOUT REQUIREMENTS

Provide disconnecting means capable of being locked out for machines and other equipment to prevent unexpected startup or release of stored energy in accordance with 29 CFR 1910.147. Mechanical isolation of machines and other equipment must be in accordance with requirements of Division 15, "Mechanical."

## PART 2 EXECUTION

### 2.1 PAINTING OF EQUIPMENT

#### 2.1.1 Factory Applied

Electrical equipment must have factory-applied painting systems which must, as a minimum, meet the requirements of NEMA ICS 6 corrosion-resistance test and the additional requirements specified in the technical sections.

### 2.1.2 Field Applied

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting must be as specified in the section specifying the associated electrical equipment.

### 2.2 NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

### 2.3 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side, but space the signs a maximum of 30 feet apart.

### 2.4 CABLE TAG INSTALLATION

Install cable tags in each handhole as specified, including each splice. Install cable tags over the fireproofing, if any, and locate the tags so that they are clearly visible without disturbing any cabling or wiring in the handholes.

## SECTION 16081N

### APPARATUS INSPECTION AND TESTING

#### PART 1 GENERAL

##### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA) NETA ATS (1999) Electrical Power Distribution Equipment and Systems

##### 1.2 RELATED REQUIREMENTS

Section 16050N, "Basic Electrical Materials and Methods" applies to this section with additions and modifications specified herein.

##### 1.3 QUALITY ASSURANCE

###### 1.3.1 Qualifications

Contractor must engage the services of a qualified testing organization to provide inspection, testing, calibration, and adjustment of the electrical distribution system and generation equipment listed in paragraph entitled "Acceptance Tests and Inspections" herein. Organization must be independent of the supplier, manufacturer, and installer of the equipment. The organization must be a first tier subcontractor. No work required by this section of the specification must be performed by a second tier subcontractor.

a. Submit name and qualifications of organization. Organization must have been regularly engaged in the testing of electrical materials, devices, installations, and systems for a minimum of 5 years. The organization must have a calibration program, and test instruments used must be calibrated in accordance with NETA ATS.

b. Submit name and qualifications of the lead engineering technician performing the required testing services. Include a list of three comparable jobs performed by the technician with specific names and telephone numbers for reference. Testing, inspection, calibration, and adjustments must be performed by an engineering technician, certified by NETA or the National Institute for Certification in Engineering Technologies (NICET) with a minimum of 5 years' experience inspecting, testing, and calibrating electrical distribution and generation equipment, systems, and devices.



### 1.3.2 Acceptance Test and Inspections Procedure

Submit test procedure reports for each item of equipment to be field tested at least 45 days prior to planned testing date. Do not perform testing until after test procedure has been approved.

## PART 2 EXECUTION

### 2.1 ACCEPTANCE TESTS AND INSPECTIONS

Testing organization must perform acceptance tests and inspections. Test methods, procedures, and test values must be performed and evaluated in accordance with NETA ATS, the manufacturer's recommendations, and paragraph entitled "Field Quality Control" of each applicable specification section. Tests identified as optional in NETA ATS are not required unless otherwise specified. Equipment must be placed in service only after completion of required tests and evaluation of the test results have been completed. Contractor must supply to the testing organization complete sets of shop drawings, settings of adjustable devices, and other information necessary for an accurate test and inspection of the system prior to the performance of any final testing. Contracting Officer must be notified at least 14 days in advance of when tests will be conducted by the testing organization. Perform acceptance tests and inspections on applicable equipment and systems specified in the following sections:

- a. Section 16365, "Power Shelter."

### 2.2 SYSTEM ACCEPTANCE

Final acceptance of the system is contingent upon satisfactory completion of acceptance tests and inspections.

### 2.3 PLACING EQUIPMENT IN SERVICE

A representative of the approved testing organization must be present when equipment tested by the organization is initially energized and placed in service.

## SECTION 16120A

### INSULATED WIRE AND CABLE

#### PART 1 GENERAL

##### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

#### ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS5	(Oct 1987; 9th Ed) Thermoplastic and Crosslinked Polyethylene Insulated Shielded Power Cables Rated 5 Through 35 kV
AEIC CS6	(Oct 1987; 5th Ed; Rev Mar 1989) Ethylene Propylene Insulated Shielded Power Cables Rated 5 Through 69 kV

#### NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA WC 7	(1988) Cross-Linked-Thermosetting- Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
NEMA WC 8	(1988) Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

##### 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following must be submitted in accordance with

#### Section 01330 SUBMITTAL PROCEDURES:

##### SD-03 Product Data

Installation Instructions; G, AE

The Contractor must submit cable manufacturing data.

## SD-06 Test Reports

Tests, Inspections, and Verifications; G, AE

2 certified copies of test reports must be submitted by the contractor.

## 1.3 DELIVERY, STORAGE, AND HANDLING

### SECTION 16120A Page 1

Furnish cables on reels or coils. Each cable and the outside of each reel or coil, must be plainly marked or tagged to indicate the cable length, voltage rating, conductor size, and manufacturer's lot number and reel number. Each coil or reel of cable must contain only one continuous cable without splices. Cables for exclusively dc applications, as specified in paragraph HIGH VOLTAGE TEST SOURCE, must be identified as such. Shielded cables rated 2,001 volts and above and must be reeled and marked in accordance with Section I of AEIC CS5 or AEIC CS6, as applicable. Reels must remain the property of the Contractor.

## 1.4 PROJECT/SITE CONDITIONS

## PART 2 PRODUCTS

### 2.1 MATERIALS

#### 2.1.1 Wire Table

Wire and cable must be furnished in accordance with the requirements of the wire table appended to these specifications, and must conform to the detailed requirements specified herein.

#### 2.1.2 Rated Circuit Voltages

All wire and cable must have minimum rated circuit voltages in accordance with Table 3-1 of NEMA WC 7 or NEMA WC 8.

#### 2.1.3 Conductors

##### 2.1.3.1 Material

Conductors must conform to all the applicable requirements of Section 2 of NEMA WC 7 or Part 2 of NEMA WC 8 as applicable and must be annealed copper. Copper conductors may be bare, or tin- or lead-alloy-coated, if required by the type of insulation used.

#### 2.1.3.2 Size

Minimum wire size must be No. 12 AWG for power and lighting circuits; No. 10 AWG for current transformer secondary circuits; No. 14 AWG for potential transformer, relaying, and control circuits; No. 16 AWG for annunciator circuits; and No. 19 AWG for alarm circuits. Minimum wire sizes for rated circuit voltages of 2,001 volts and above must not be less than those listed for the applicable voltage in Table 3-1 of Section 3 of NEMA WC 7 or Part 3 of NEMA WC 8, as applicable.

#### 2.1.3.3 Stranding

Conductor stranding classes cited herein must be as defined in Appendix L of NEMA WC 7 or NEMA WC 8, as applicable. Lighting conductors No. 10 AWG and smaller must be solid or have Class B stranding. Any conductors used between stationary and moving devices, such as hinged doors or panels, must have Class H or K stranding. All other conductors must have Class B or C stranding, except that conductors shown on the drawings, or in the schedule, as No. 12 AWG may be 19 strands of No. 25 AWG, and conductors shown as No. 10 AWG may be 19 strands of No. 22 AWG.

#### 2.1.3.4 Conductor Shielding

Conductor shielding conforming to paragraph 2.7 of NEMA WC 7 or NEMA WC 8, as applicable, must be used on power cables having a rated circuit voltage above 2,000 volts. In addition, conductor shielding for shielded cables must also comply with Section C of AEIC CS5 or AEIC CS6. Strict precautions must be taken after application of the conductor shielding to prevent the inclusion of voids or contamination between the conductor shielding and the subsequently applied insulation.

#### 2.1.3.5 Separator Tape

Where conductor shielding, strand filling, or other special conductor treatment is not required, a separator tape between conductor and insulation is permitted.

#### 2.1.4 Insulation

##### 2.1.4.1 Insulation Material

Insulation must be ethylene-propylene rubber (EPR) type meeting the requirements of Part 3 of NEMA WC 8. For shielded cables of rated circuit voltages above 2,000 volts, the following provisions must also apply:

- a. Insulation must be chemically bonded to conductor shielding.
- b. The insulation material and its manufacturing, handling, extrusion and vulcanizing processes, must all be subject to strict procedures to prevent the inclusion of voids, contamination, or other irregularities on or in the insulation. Insulation material must be

inspected for voids and contaminants. Inspection methods, and maximum allowable void and contaminant content must be in accordance with Section B of AEIC CS5 or AEIC CS6, as applicable.

c. Cables with repaired insulation defects discovered during factory testing, or with splices or insulation joints, are not acceptable.

#### 2.1.4.2 Insulation Thickness

The insulation thickness for each conductor must be based on its rated circuit voltage.

a. Power Cables/Single-Conductor Control Cables, 2,000 Volts and Below - The insulation thickness for single-conductor cables rated 2,000 volts and below must be as required by Table 3-1, Section 3 of NEMA WC 7 or Table 3-1, Part 3, of NEMA WC 8, as applicable. Column "A" thickness of Table 3-1 of NEMA WC 7 will be permitted only for single-conductor cross-linked thermosetting polyethylene insulated cables without a jacket. NEMA WC 8 ethylene-propylene rubber-insulated conductors must have a jacket. Column "B" thickness must apply to single-conductor cables that require a jacket and to individual conductors of multiple-conductor cables with an overall jacket.

b. Power Cables, Rated 2,001 Volts and Above - Thickness of insulation for power cables rated 2,001 volts and above must be in accordance with the following:

(1) Shielded cables rated 2,001 volts and above must comply with Column B of Table B1, of AEIC CS5 or AEIC CS6, as applicable.

c. Multiple-Conductor Control Cables - The insulation thickness of multiple-conductor cables used for control and related purposes must be as required by Table 7-32 of NEMA WC 7 or Table 7.5.1 of NEMA WC 8 as applicable.

#### 2.1.4.3 Insulation Shielding

Unless otherwise specified, insulation shielding must be provided for conductors having rated circuit voltages of 2,001 volts and above. The voltage limits above which insulation shielding is required, and the material requirements, are given in Section 4 of NEMA WC 7 or Part 4 of NEMA WC 8, as applicable. The material, if thermosetting, must meet the wafer boil test requirements as described in Section D of AEIC CS5 or AEIC CS6, as applicable. The method of shielding must be in accordance with the current practice of the industry; however, the application process must include strict precautions to prevent voids or contamination between the insulation and the nonmetallic component. Voids, protrusions, and indentations of the shield must not exceed the maximum allowances specified in Section C of AEIC CS5 or AEIC CS6, as applicable. The cable must be capable of operating without damage or excessive temperature when the shield is grounded at both ends of each conductor. All components of the shielding system must remain tightly applied to the components they enclose after

handling and installation in accordance with the manufacturer's recommendations. Shielding systems which require heat to remove will not be permitted unless specifically approved.

#### 2.1.5 Jackets

All cables must have jackets meeting the requirements of Section 4 of NEMA WC 7, or Part 4 of NEMA WC 8, as applicable, and as specified herein. Individual conductors of multiple-conductor cables must be required to have jackets only if they are necessary for the conductor to meet other specifications herein. Jackets of single-conductor cables and of individual conductors of multiple-conductor cables, except for shielded cables, must be in direct contact and adhere or be vulcanized to the conductor insulation. Multiple-conductor cables and shielded single-conductor cables must be provided with a common overall jacket, which must be tightly and concentrically formed around the core. Repaired jacket defects found and corrected during manufacturing are permitted if the cable, including jacket, afterward fully meets these specifications and the requirements of the applicable standards.

##### 2.1.5.1 Jacket Material

The jacket must be one of the materials listed below.

a. General Use

- (1) Heavy-duty black neoprene (NEMA WC 8, paragraph 4.4.3).
- (2) Heavy-duty chlorosulfonated polyethylene (NEMA WC 8, paragraph 4.4.10).
- (3) Heavy-duty cross-linked (thermoset) chlorinated polyethylene (NEMA WC 8, paragraph 4.4.11).

b. Accessible Use Only, 2,000 Volts or Less - Cables installed where they are entirely accessible, such as cable trays and raceways with removable covers, or where they pass through less than 10 feet of exposed conduit only, must have jackets of one of the materials specified in above paragraph GENERAL USE, or the jackets may be of one of the following:

- (1) General-purpose neoprene (NEMA WC 8, paragraph 4.4.4).
- (2) Black polyethylene (NEMA WC 8, paragraph 4.4.6).
- (3) Thermoplastic chlorinated polyethylene (NEMA WC 8, paragraph 4.4.7).

##### 2.1.5.2 Jacket Thickness

The minimum thickness of the jackets at any point must be not less than 80 percent of the respective nominal thickness specified below.

a. Multiple-Conductor Cables - Thickness of the jackets of the individual conductors of multiple-conductor cables must be as required by Section 4, Table 4-6 of NEMA WC 7 or Part 4, Table 4-4 of NEMA WC 8, and must be in addition to the conductor insulation thickness required by Column B of Table 3-1 of the applicable NEMA publication for the insulation used. Thickness of the outer jackets or sheaths of the assembled multiple-conductor cables must be as required by Section 4, Table 4-7, of NEMA WC 7 or Part 4, Table 4-5, of NEMA WC 8.

b. Single-Conductor Cables - Single-conductor cables, if nonshielded, must have a jacket thickness as specified in Section 4, Table 4-4 of NEMA WC 7 or Part 4, Table 4-2 of NEMA WC 8. If shielded, the jacket thickness must be in accordance with the requirements of Section 4, Table 4-5 of NEMA WC 7 or Part 4, Table 4-3 of NEMA WC 8.

#### 2.1.6 Identification

##### 2.1.6.1 Color-coding

Insulation of individual conductors of multiple-conductor cables must be color-coded in accordance with paragraph 5.3 of NEMA WC 8, except that colored braids will not be permitted. Only one color-code method must be used for each cable construction type. Control cable color-coding must be in accordance with Table 5-2 of NEMA WC 8. Power cable color-coding must be black for Phase A, red for Phase B, blue for Phase C, white for grounded neutral, and green for an insulated grounding conductor, if included.

##### 2.1.6.2 Shielded Cables Rated 2,001 Volts and Above

Marking must be in accordance with Section H of AEIC CS5 or AEIC CS6, as applicable.

#### 2.1.7 Cabling

Individual conductors of multiple-conductor cables must be assembled with flame-and moisture-resistant fillers, binders, and a lay conforming to Part 5 of NEMA WC 8, except that flat twin cables will not be permitted. Fillers must be used in the interstices of multiple-conductor round cables with a common covering where necessary to give the completed cable a substantially circular cross section. Fillers must be non-hygroscopic material, compatible with the cable insulation, jacket, and other components of the cable. The rubber-filled or other approved type of binding tape must consist of a material that is compatible with the other components of the cable and must be lapped at least 10 percent of its width.

#### 2.1.8 Dimensional Tolerance

The outside diameters of single-conductor cables and of multiple-conductor cables must not vary more than 5 percent and 10 percent, respectively, from the manufacturer's published catalog data.

## 2.2 INSTALLATION INSTRUCTIONS

The following information must be provided by the cable manufacturer for each size, conductor quantity, and type of cable furnished:

- a. Minimum bending radius, in inches - For multiple-conductor cables, this information must be provided for both the individual conductors and the multiple-conductor cable.
- b. Pulling tension and sidewall pressure limits, in pounds.
- c. Instructions for stripping semiconducting insulation shields, if furnished, with minimum effort without damaging the insulation.
- d. Upon request, compatibility of cable materials and construction with specific materials and hardware manufactured by others must be stated. Also, if requested, recommendations must be provided for various cable operations, including installing, splicing, terminating, etc.

## 2.3 TESTS, INSPECTIONS, AND VERIFICATIONS

### 2.3.1 Cable Data

Manufacture of the wire and cable must not be started until all materials to be used in the fabrication of the finished wire or cable have been approved by the Contracting Officer. Cable data must be submitted for approval including dimensioned sketches showing cable construction, and sufficient additional data to show that these specifications will be satisfied.

### 2.3.2 Inspection and Tests

Inspection and tests of wire and cable furnished under these specifications must be made by and at the plant of the manufacturer, and must be witnessed by the Contracting Officer or his authorized representative, unless waived in writing. The Government may perform further tests before or after installation. Testing in general must comply with Section 6 of NEMA WC 7 or Part 6 of NEMA WC 8. Specific tests required for particular materials, components, and completed cables must be as specified in the sections of the above standards applicable to those materials, components, and cable types. Tests must also be performed in accordance with the additional requirements specified below.

#### 2.3.2.1 High-Voltage Test Source

Where the applicable standards allow a choice, high-voltage tests for cables to be used exclusively on dc circuits must be made with dc test voltages. Cables to be used exclusively on ac circuits must be tested with ac test voltages. If both ac and dc will be present, on either the same or separate conductors of the cable, ac test voltages must be used.



#### 2.3.2.2 Shielded Cables Rated 2,001 Volts or Greater

The following tests must be performed in addition to those specified above. Section or paragraph references are to AEIC CS5 or AEIC CS6 as applicable, unless otherwise stated.

- a. High potential test voltages must be as required by Table B1 of AEIC CS5 or AEIC CS6 as applicable, rather than by Table 3-1 of NEMA WC 7 or NEMA WC 8.
- b. If high potential testing is done with an ac test voltage as specified in paragraph HIGH-VOLTAGE TEST SOURCE, an additional test must be made using a dc test voltage rated at 75 percent of the specified full dc test voltage, for 5 consecutive minutes.
- c. Production sampling tests must be performed in accordance with Section D. Sampling frequency and failure contingencies must be in accordance with paragraph G.3. Unless otherwise approved, samples must not be taken from the middle of extruder runs of insulation or shielding made only for one continuous shipping length of cable, if such sampling will result in the need to repair the sampled area.
- d. Partial discharge tests must be performed in accordance with Section E, paragraph E.2, and Section F.

#### 2.3.2.3 Independent Tests

The Government may at any time make visual inspections, continuity or resistance checks, insulation resistance readings, power factor tests, or dc high-potential tests at field test values. A cable's failure to pass these tests and inspections, or failure to produce readings consistent with acceptable values for the application, will be grounds for rejection of the cable.

#### 2.3.2.4 Reports

Results of tests made must be furnished. No wire or cable must be shipped until authorized. Lot number and reel or coil number of wire and cable tested must be indicated on the test reports.

## WIRE TABLE |

Size, Rated

Item	AWG or No. of Circuit	Quantity	No. kcmil	Conds.	Voltage	Stranding	Comments	lin. ft.
------	-----------------------	----------	-----------	--------	---------	-----------	----------	----------

[illegible]

## SECTION 16402N

## INTERIOR DISTRIBUTION SYSTEM

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

**AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)**

ASTM B1	(1995) Hard-Drawn Copper Wire
ASTM B8	(1999) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

**NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)**

NEMA C80.3	(1994) Electrical Metallic Tubing – Zinc Coated (EMT)
NEMA ICS 1	(1993) Industrial Control and Systems
NEMA ICS 2	(1993) Industrial Control and Systems Controllers, Contactors and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC
NEMA ICS 4	(1997) Terminal Blocks
NEMA ICS 6	(1993) Industrial Control and Systems Enclosures
NEMA MG 1	(1998; Errata 1999) Motors and Generators
NEMA MG 10	(1994) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
NEMA MG 11	(1977; R 1992) Energy Management Guide for Selection and Use of Single-Phase Motors
NEMA ST 20	(1992) Dry-Type Transformers for General Applications
NEMA VE 1	(1998) Metal Cable Tray Systems
NEMA WD 1	(1999) General Color Requirements for Wiring Devices

NEMA WD 6	(1997) Wiring Devices – Dimensional Specifications
INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)	
NETA ATS	(1999) Electrical Power Distribution Equipment and Systems
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)	
NFPA 70	(1999) National Electrical Code
UNDERWRITERS LABORATORIES INC. (UL)	
UL 1	(2000) Flexible Metal Conduit
UL 50	(1995; R 1999, Bul. 1999) Safety Enclosures for Electrical Equipment
UL 67	(1993; R 2000, Bul. 2000) Panelboards
UL 83	(1998; R 1999, Bul. 1999 and 2000)
Thermoplastic-Insulated Wires and Cables	
UL 360	(1996; R 1997) Liquid-Tight Flexible Steel Conduit
UL 467	(1993; R 1999, Bul. 2000) Grounding and Bonding Equipment
UL 486A	(1997; R 2000) Wire Connectors and Soldering Lugs for Use with Copper Conductors
UL 486C	(2000) Splicing Wire Connectors
UL 489	(1996; R 2000, Bul. 1999 and 2000) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 498	(1996; R 1999, Bul. 1999 and 2000) Attachment Plugs and Receptacles
UL 506	(2000) Specialty Transformers
UL 508	(1999; R 2000, Bul. 1999 and 2000) Industrial Control Equipment
UL 510	(1994; R 1998) Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape
UL 514A	(1996; R 1999, Bul. 2000) Metallic Outlet Boxes

UL 514B	(1997; R 1998, Bul. 1999) Fittings for Cable and Conduit
UL 514C	(1996; R 2000, Bul. 1999 and 2000) Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 797	(2000) Electrical Metallic Tubing
UL 869A	(1998) Service Equipment
UL 943	(1993; R 2000, Bul. 1999 and 2000) Ground-Fault Circuit-Interrupters
UL 984	(1996, Bul. 1999) Hermetic Refrigerant Motor-Compressors
UL 1449	(1996; R 2000, Bul. 1999 and 2000) Transient Voltage Surge Suppressors
UL 1660	(2000) Liquid-Tight Flexible Nonmetallic Conduit

## 1.2 RELATED REQUIREMENTS

Section 16050N, "Basic Electrical Materials and Methods," applies to this section with additions and modifications specified herein.

## 1.3 MAINTENANCE

### 1.3.1 Electrical Systems

Submit operation and maintenance manuals for electrical systems that provide basic data relating to the design, operation, and maintenance of the electrical distribution system for the building. This must include:

- a. Single line diagram of the "as-built" building electrical system.
- b. Manufacturers' operating and maintenance manuals on active electrical equipment.

## PART 2 PRODUCTS

### 2.1 MATERIALS AND EQUIPMENT

Materials, equipment, and devices must, as a minimum, meet requirements of UL, where UL standards are established for those items, and requirements of NFPA 70.

## 2.2 CONDUIT AND FITTINGS

Must conform to the following:

### 2.2.1 Electrical Metallic Tubing (EMT)

UL 797, NEMA C80.3.

### 2.2.2 Flexible Metal Conduit

UL 1.

#### 2.2.2.1 Liquid-Tight Flexible Metal Conduit, Steel

UL 360.

### 2.2.3 Fittings for Metal Conduit, EMT, and Flexible Metal Conduit

UL 514B. Ferrous fittings must be cadmium- or zinc-coated in accordance with UL 514B.

#### 2.2.3.1 Fittings for EMT

Steel compression type.

### 2.2.4 Liquid-Tight Flexible Nonmetallic Conduit

UL 1660.

## 2.3 CABLE TRAYS

NEMA VE 1. Cable trays must form a wire way system, and must be of nominal 3-inch depth. Cable trays must be constructed of steel that has been zinc-coated after fabrication. Trays must include splice and end plates, dropouts, and miscellaneous hardware. Edges, fittings, and hardware must be finished free from burrs and sharp edges. Fittings must have not less than load-carrying ability of straight tray sections and must have manufacturer's minimum standard radius. Radius of bends must be 12 inches.

### 2.3.1 Ladder-Type Cable Trays

Sized as indicated.

## 2.4 OUTLET BOXES AND COVERS

UL 514A, cadmium- or zinc-coated, if ferrous metal. UL 514C, if nonmetallic.

## 2.5 CABINETS, JUNCTION BOXES, AND PULL BOXES

Volume greater than 100 cubic inches, UL 50, hot-dip, zinc-coated, if sheet steel.

## 2.6 WIRES AND CABLES

Wires and cables must meet applicable requirements of NFPA 70 and UL for type of insulation, jacket, and conductor specified or indicated. Wires and cables manufactured more than 12 months prior to date of delivery to site must not be used.

### 2.6.1 Conductors

Conductors No. 8 AWG and larger diameter must be stranded. Conductors No.10 AWG and smaller diameter must be solid. Conductor sizes and ampacities shown are based on copper, unless indicated otherwise. All conductors must be copper.

#### 2.6.1.1 Equipment Manufacturer Requirements

When manufacturer's equipment requires copper conductors at the terminations or requires copper conductors to be provided between components of equipment, provide copper conductors or splices, splice boxes, and other work required to satisfy manufacturer's requirements.

### 2.6.2 Color Coding

Provide for service, feeder, branch, control, and signaling circuit conductors. Color must be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in same raceway or box, other neutral must be white with colored (not green) stripe. Color of ungrounded conductors in different voltage systems must be as follows:

#### a. 208/120 volt, three-phase

- (1) Phase A - black
- (2) Phase B - red
- (3) Phase C - blue

#### b. 480/277 volt, three-phase

- (1) Phase A - brown
- (2) Phase B - orange
- (3) Phase C – yellow

### 2.6.3 Insulation

Unless specified or indicated otherwise or required by NFPA 70, power and lighting wires must be 600-volt, Type THWN/THHN conforming to UL 83. Where lighting fixtures require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

### 2.6.4 Bonding Conductors

ASTM B1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

### 2.6.5 Cable Tray Cable

UL listed; type TC.

## 2.7 SPLICES AND TERMINATION COMPONENTS

UL 486A for wire connectors and UL 510 for insulating tapes. Connectors for No. 10 AWG and smaller diameter wires must be insulated, pressure-type in accordance with UL 486A or UL 486C (twist-on splicing connector). Provide solderless terminal lugs on stranded conductors.

## 2.8 DEVICE PLATES

Provide UL listed, one-piece device plates for outlets to suit the devices installed. For metal outlet boxes, plates on unfinished walls must be of zinc-coated sheet steel or cast metal having round or beveled edges. For nonmetallic boxes and fittings, other suitable plates may be provided. Plates on finished walls must be satin finish stainless steel or brushed-finish aluminum, minimum 0.03 inch thick. Screws must be machine-type with countersunk heads in color to match finish of plate. Sectional type device plates will not be permitted. Plates installed in wet locations must be gasketed and UL listed for "wet locations."

## 2.9 SWITCHES

### 2.9.1 Toggle Switches

NEMA WD 1, No. 1121 for single pole, No. 1122 for double pole, No. 1123 for three-way, and No. 1124 for four-way, totally enclosed with bodies of thermosetting plastic and mounting strap with grounding screw. Handles must be brown. Wiring terminals must be screw-type, side-wired. Switches must be rated quiet-type ac only, 120/277 volts.

### 2.9.2 Breakers Used as Switches

For 120- and 277-Volt fluorescent fixtures, mark breakers "SWD" in accordance with UL 489.



## 2.10 RECEPTACLES

UL 498 and NEMA WD 1, general grade, heavy-duty, grounding-type. Ratings and configurations must be as indicated. Bodies must be of brown thermosetting plastic supported on a metal mounting strap. Dimensional requirements must be per NEMA WD 6. Provide screw-type, side-wired wiring terminals. Connect grounding pole to mounting strap.

### 2.10.1 Duplex Receptacles

Duplex receptacles must be 20amperes, 125 volts, No. 5342.

### 2.10.2 Switched Duplex Receptacles

Provide separate terminals for each ungrounded pole. Top receptacle must be switched when installed.

### 2.10.3 Weatherproof Receptacles

Provide in cast metal box with gasketed, weatherproof, cast-metal cover plate and gasketed cap over each receptacle opening. Provide caps with a spring-hinged flap. Receptacle must be UL listed for use in "wet locations with plug in use."

### 2.10.4 Ground-Fault Circuit Interrupter Receptacles

UL 943, duplex type for mounting in standard outlet box. Device must be capable of detecting current leak of 6 milliamperes or greater and tripping per requirements of UL 943 for Class A GFCI devices.

### 2.10.5 Special Purpose Pin and Sleeve Receptacles

Receptacles serving Conex trailers are special purpose. Provide in ratings indicated. Furnish one matching plug with each receptacle.

### 2.10.6 Plugs

Provide heavy-duty, rubber-covered wire cord of required size, install plugs thereon, and attach to equipment. Plugs must be UL listed with receptacles, complete with grounding blades. Where equipment is not available, turn over plugs and cord assemblies to the Government.

## 2.11 PANELBOARDS

UL 67 and UL 50 having a short-circuit current rating as indicated. Panelboards for use as service disconnecting means must additionally conform to UL 869A. Panelboards must be circuit breaker-equipped. Design must be such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL. "Specific breaker placement" is required in

panelboards to match the breaker placement indicated in the panelboard schedule on the drawings. Use of "Subfeed Breakers" is not acceptable unless specifically indicated otherwise. Main breaker must be "separately" mounted "above" branch breakers. Where "space only" is indicated, make provisions for future installation of breakers. Panelboard locks must be keyed same. Directories must indicate load served by each circuit in panelboard. Directories must also indicate source of service to panelboard (e.g., Panel PA served from Panel MDP). Type directories and mount in holder behind transparent protective covering. Panelboards must be listed and labeled for their intended use.

#### 2.11.1 Panelboard Buses

Support bus bars on bases independent of circuit breakers. Main buses and back pans must be designed so that breakers may be changed without machining, drilling, or tapping. Provide isolated neutral bus in each panel for connection of circuit neutral conductors. Provide separate ground bus identified as equipment grounding bus per UL 67 for connecting grounding conductors; bond to steel cabinet.

#### 2.11.2 Circuit Breakers

UL 489, solid state-type having a minimum short-circuit current rating equal to the short-circuit current rating of the panelboard in which the circuit breaker must be mounted. Breaker terminals must be UL listed as suitable for type of conductor provided. Series rated circuit breakers and plug-in circuit breakers are unacceptable.

##### 2.11.2.1 Multipole Breakers

Provide common trip-type with single operating handle. Breaker design must be such that overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any three adjacent breaker poles are connected to Phases A, B, and C, respectively.

##### 2.11.2.2 Circuit Breakers for HVAC Equipment

Circuit breakers for HVAC equipment having motors (group or individual) must be marked for use with HACR type and UL listed as HACR type.

#### 2.12 ENCLOSED CIRCUIT BREAKERS

UL 489. Individual molded case circuit breakers with voltage and continuous current ratings, number of poles, overload trip setting, and short circuit current interrupting rating as indicated. Enclosure type as indicated.

#### 2.13 TRANSFORMERS

NEMA ST 20, general purpose, dry-type, self-cooled, ventilated. Provide transformers in NEMA 1 enclosure. Transformer must have 220 degrees C insulation system for transformers 15 kva and greater, and must have 180 degrees C insulation for transformers rated 10 kva and less,

with temperature rise not exceeding 80 degrees C under full-rated load in maximum ambient of 40 degrees C. Transformer of 80 degrees C temperature rise must be capable of carrying continuously 130 percent of nameplate kVA without exceeding insulation rating. Transformers must be quiet type with maximum sound level at least 3 decibels less than NEMA standard level for transformer ratings indicated.

#### 2.13.1 Transmitter Array Transformer (Heavy Duty)

As manufactured by Sola, Cat. #LVGP/3PH T81H112S.

#### 2.13.2 Receiver Array Transformer

As manufactured by Lockheed Martin, Cat. #20514915-1.

### 2.14 MOTORS

NEMA MG 1; hermetic-type sealed motor compressors must also comply with UL 984. Provide the size in terms of HP, or kVA, or full-load current, or a combination of these characteristics, and other characteristics, of each motor as indicated or specified. Determine specific motor characteristics to ensure provision of correctly sized starters and overload heaters. Motors for operation on 208-volt, 3-phase circuits must have terminal voltage rating of 200 volts, and those for operation on 480-volt, 3-phase circuits must have terminal voltage rating of 460 volts. Motors must be designed to operate at full capacity with voltage variation of plus or minus 10 percent of motor voltage rating.

#### 2.14.1 High Efficiency Single-Phase Motors

Single-phase fractional-horsepower alternating-current motors must be high efficiency types corresponding to the applications listed in NEMA MG 11.

#### 2.14.2 High Efficiency Polyphase Motors

Polyphase motors must be selected based on high efficiency characteristics relative to the applications as listed in NEMA MG 10. Additionally, polyphase squirrel-cage medium induction motors with continuous ratings must meet or exceed energy efficient ratings in accordance with Table 12-10 of NEMA MG 1.

#### 2.14.3 Motor Sizes

Provide size for duty to be performed, not exceeding the full-load nameplate current rating when driven equipment is operated at specified capacity under most severe conditions likely to be encountered. When motor size provided differs from size indicated or specified, make adjustments to wiring, disconnect devices, and branch circuit protection to accommodate equipment actually provided.

## 2.15 MOTOR CONTROLLERS

UL 508, NEMA ICS 1, and NEMA ICS 2. Controllers must have thermal overload protection in each phase and must have one spare normally open and one spare normally closed auxiliary contact. Magnetic-type motor controllers must have undervoltage protection when used with momentary-contact pushbutton stations or switches and must have undervoltage release when used with maintained-contact pushbutton stations or switches. When used with pressure, float, or similar automatic-type or maintained-contact switch, controller must have hand/off/automatic selector switch. Connections to selector switch must be such that only normal automatic regulatory control devices are bypassed when switch is in "hand" position. Safety control devices, such as low and high pressure cutouts, high temperature cutouts, and motor overload protective devices, must be connected in motor control circuit in "hand" and "automatic" positions. Control circuit connections to hand/off/automatic selector switch or to more than one automatic regulatory control device must be made in accordance with indicated or manufacturer's approved wiring diagram. For each motor not in sight of controller or where controller disconnecting means is not in sight of motor location and driven machinery location, controller disconnecting means must be capable of being locked in open position. As an alternative, provide a manually operated, lockable, nonfused switch which disconnects motor from supply source within sight of motor. Overload protective devices must provide adequate protection to motor windings; be thermal inverse-time-limit type; and include manual reset-type pushbutton on outside of motor controller case. Cover of combination motor controller and manual switch or circuit breaker must be interlocked with operating handle of switch or circuit breaker so that cover cannot be opened unless handle of switch or circuit breaker is in "off" position.

### 2.15.1 Control Circuits

Control circuits must have maximum voltage of 120 volts derived from control transformer in same enclosure. Transformers must conform to UL 506, as applicable. Transformers, other than transformers in bridge circuits, must have primaries wound for voltage available and secondaries wound for correct control circuit voltage. Size transformers so that 80 percent of rated capacity equals connected load. Provide disconnect switch on primary side. One secondary lead must be fused; other must be grounded.

### 2.15.2 Enclosures for Motor Controllers

NEMA ICS 6.

### 2.15.3 Pushbutton Stations

Provide with "start/stop" momentary contacts having one normally open and one normally closed set of contacts, and red lights to indicate when motor is running. Stations must be heavy duty, oil-tight design.

#### 2.15.4 Pilot and Indicating Lights

Provide LED cluster lamps.

#### 2.15.5 Terminal Blocks

NEMA ICS 4.

### 2.16 GROUNDING AND BONDING EQUIPMENT

UL 467. Ground rods must be copper-clad steel, with minimum diameter of 3/4 inch and minimum length of 10 feet.

### 2.17 NAMEPLATES

Provide as specified in Section 16050N, "Basic Electrical Materials and Methods."

### 2.18 TRANSIENT VOLTAGE SURGE SUPPRESSORS

Provide Transient Voltage Surge Suppression (TVSS) devices which comply with UL 1449.

### 2.19 SOURCE QUALITY CONTROL

#### 2.19.1 Transformer Factory Tests

Submittal must include routine NEMA ST 20 transformer test results on each transformer and also contain the results of NEMA "design" and "prototype" tests that were made on transformers electrically and mechanically equal to those specified.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Electrical installations must conform to requirements of NFPA 70 and to requirements specified herein.

#### 3.1.1 Underground Service

Underground service conductors and associated conduit must be continuous from service entrance equipment to outdoor power system connection.

#### 3.1.2 Service Entrance Identification

Service entrance disconnect devices, switches, and enclosures must be labeled and identified as such.

### 3.1.2.1 Labels

Wherever work results in service entrance disconnect devices in more than one enclosure, as permitted by NFPA 70, each enclosure, new and existing, must be labeled as one of several enclosures containing service entrance disconnect devices. Label, at minimum, must indicate number of service disconnect devices housed by enclosure and must indicate total number of enclosures that contain service disconnect devices. Provide laminated plastic labels conforming to paragraph entitled "Nameplates." Use lettering of at least 0.25 inch in height, and engrave on black-on-white matte finish. Service entrance disconnect devices in more than one enclosure, must be provided only as permitted by NFPA 70.

### 3.1.3 Wiring Methods

Provide insulated conductors installed in EMT, except where specifically indicated or specified otherwise or required by NFPA 70 to be installed otherwise. Grounding conductor must be separate from electrical system neutral conductor. Provide insulated green equipment grounding conductor for circuit(s) installed in conduit and raceways.

#### 3.1.3.1 Restrictions Applicable to EMT

- a. Do not install underground.
- b. Do not encase in concrete, mortar, grout, or other cementitious materials.
- c. Do not use in areas subject to severe physical damage including but not limited to equipment rooms where moving or replacing equipment could physically damage the EMT.
- d. Do not use in hazardous areas.
- e. Do not use outdoors.
- f. Do not use in fire pump rooms.

#### 3.1.3.2 Restrictions Applicable to Flexible Conduit

Use only as specified in paragraph entitled "Flexible Connections."

### 3.1.4 Conduit Installation

Install conduit parallel with or at right angles to ceilings, walls, and structural members where located above accessible ceilings and where conduit will be visible after completion of project.

#### 3.1.4.1 Conduit Support

Support conduit by pipe straps, wall brackets, hangers, or ceiling trapeze. Fasten by machine screws, welded threaded studs, or spring-tension clamps on steel work. Do not weld conduits or pipe straps to steel structures. Load applied to fasteners must not exceed one-fourth proof

test load. Fasteners attached to concrete ceiling must be vibration resistant and shock-resistant. In partitions of light steel construction, use sheet metal screws

#### 3.1.4.2 Directional Changes in Conduit Runs

Make changes in direction of runs with symmetrical bends or cast-metal fittings. Make field-made bends and offsets with hickey or conduit-bending machine. Do not install crushed or deformed conduits. Avoid trapped conduits. Prevent plaster, dirt, or trash from lodging in conduits, boxes, fittings, and equipment during construction. Free clogged conduits of obstructions.

#### 3.1.4.3 Pull Wire

Install pull wires in empty conduits. Pull wire must be plastic having minimum 200-pound tensile strength. Leave minimum 36 inches of slack at each end of pull wire.

#### 3.1.4.4 Locknuts and Bushings

Fasten conduits to sheet metal boxes and cabinets with two locknuts where required by NFPA 70, where insulated bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, use at least minimum single locknut and bushing. Locknuts must have sharp edges for digging into wall of metal enclosures. Install bushings on ends of conduits, and provide insulating type where required by NFPA 70.

#### 3.1.4.5 Flexible Connections

Provide flexible steel conduit between 3 and 6 feet in length for lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for motors. Install flexible conduit to allow 20 percent slack. Minimum flexible steel conduit size must be 1/2 inch diameter. Provide liquid tight flexible metallic conduit in wet and damp locations for equipment subject to vibration, noise transmission, movement, or motors. Provide separate ground conductor across flexible connections.

#### 3.1.5 Cable Tray Installation

Install and ground per NFPA 70, Article 318. Install cable trays parallel with or at right angles to Conex trailers. Support as indicated. Adjacent cable tray sections must be bonded together by connector plates of an identical type as the cable tray sections. For grounding of cable tray system provide No. 2 AWG bare copper wire throughout cable tray system, and bond to each section.

#### 3.1.6 Boxes, Outlets, and Supports

Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways must be cast-metal, hub-type when located in wet locations, when surface mounted on outside of exterior surfaces, and when specifically indicated. Boxes in other locations must be sheet steel. Each

box must have volume required by NFPA 70 for number of conductors enclosed in box. Boxes for mounting lighting fixtures must be minimum 4 inches square, or octagonal, except that smaller boxes may be installed as required by fixture configurations, as approved. Provide gaskets for cast-metal boxes installed in wet locations. Fixtures must be readily removable for access to boxes unless ceiling access panels are provided. Support boxes and pendants for surface-mounted fixtures on suspended ceilings independently of ceiling supports, or make adequate provisions for distributing load over ceiling support members in an approved manner. Fasten boxes and supports with machine screws or welded studs on steel.

#### 3.1.6.1 Boxes

Boxes for use with raceway systems must be minimum 1-1/2 inches deep, except where mustower boxes required by structural conditions are approved. Boxes for other than lighting fixture outlets must be minimum 4 inches square, except that 4 by 2 inch boxes may be used where only one raceway enters outlet.

#### 3.1.6.2 Pull Boxes

Construct of at least minimum size required by NFPA 70 of code-gauge galvanized sheet steel, except where cast-metal boxes are required in locations specified herein. Provide boxes with screw-fastened covers. Where several feeders pass through common pull box, tag feeders to indicate clearly electrical characteristics, circuit number, and panel designation.

#### 3.1.7 Mounting Heights

Mount panelboards, enclosed circuit breakers, motor controller and disconnecting switches so height of operating handle at its highest position is maximum 78 inches above floor. Mount lighting switches 48 inches above finished floor, receptacles 18 inches above finished floor. Measure mounting heights of wiring devices and outlets to center of device or outlet.

#### 3.1.8 Conductor Identification

Provide conductor identification within each enclosure where tap, splice, or termination is made. For conductors No. 6 AWG and smaller diameter, color-coding must be by factory-applied, color-impregnated insulation. For conductors No. 4 AWG and larger diameter, color-coding must be by plastic-coated, self-sticking markers; colored nylon cable ties and plates; or heat shrink-type sleeves.

#### 3.1.9 Splices

Make splices in accessible locations. Make splices in conductors No. 10 AWG and smaller diameter with insulated, pressure-type connector. Make splices in conductors No. 8 AWG and larger diameter with solderless connector, and cover with insulation material equivalent to conductor insulation.



### 3.1.10 Covers and Device Plates

Install with edges in continuous contact with finished wall surfaces without use of mats or similar devices. Plaster fillings are not permitted. Install plates with alignment tolerance of 1/16 inch. Use of sectional-type device plates are not permitted. Provide gasket for plates installed in wet locations.

### 3.1.11 Grounding and Bonding

In accordance with NFPA 70. Ground exposed, non-current-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductor in metallic raceways. Interconnect all grounding media in or on the structure to provide a common ground potential. This must include lightning protection and electrical service. Use main size lightning conductors for interconnecting these grounding systems to the lightning protection system.

#### 3.1.11.1 Resistance

Maximum resistance-to-ground of grounding system must not exceed 5 ohms under dry conditions. Where resistance obtained exceeds 5 ohms, contact Contracting Officer for further instructions.

### 3.1.12 Equipment Connections

Provide power wiring for the connection of motors and control equipment under this section of the specification. Except as otherwise specifically noted or specified, automatic control wiring, control devices, and protective devices within the control circuitry are not included in this section of the specifications but must be provided under the section specifying the associated equipment.

## 3.2 FIELD QUALITY CONTROL

Furnish test equipment and personnel and submit written copies of test results. Give Contracting Officer 5 working days notice prior to tests.

### 3.2.1 Devices Subject to Manual Operation

Each device subject to manual operation must be operated at least five times, demonstrating satisfactory operation each time.

### 3.2.2 600-Volt Wiring Test

Test wiring rated 600 volt and less to verify that no short circuits or accidental grounds exist. Perform insulation resistance tests on wiring No. 6 AWG and larger diameter using instrument which applies voltage of approximately 500 volts to provide direct reading of resistance. Minimum resistance must be 250,000 ohms.

### 3.2.3 Transformer Tests

Perform the standard, not optional, tests in accordance with the Inspection and Test Procedures for transformers, dry type, air-cooled, 600 volt and below; as specified in NETA ATS. Measure primary and secondary voltages for proper tap settings. Tests need not be performed by a recognized independent testing firm or independent electrical consulting firm.

### 3.2.4 Ground-Fault Receptacle Test

Test ground-fault receptacles with a "load" (such as a plug in light) to verify that the "line" and "load" leads are not reversed.

### 3.2.5 Grounding System Test

Test grounding system to ensure continuity, and that resistance to ground is not excessive. Test each ground rod for resistance to ground before making connections to rod; tie grounding system together and test for resistance to ground. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall. Submit written results of each test to Contracting Officer, and indicate location of rods as well as resistance and soil conditions at time measurements were made.

## SECTION 01781

### OPERATION AND MAINTENANCE DATA

#### PART 1 GENERAL

##### 1.1 SUBMISSION OF OPERATION AND MAINTENANCE DATA

Submit Operation and Maintenance (O&M) Data/Manuals, which are specifically applicable to this contract and a complete and concise depiction of the provided equipment or product. Organize and present information in sufficient detail to clearly explain O&M requirements at the system, equipment, component, and subassembly level.

###### 1.1.1 Quantity

Submit five sets of the supplier/manufacturers' O&M information specified herein for the components, assemblies, subassemblies, attachments, and accessories. The items for which O&M Data/Manuals are required are listed in the technical sections which specifies those particular items.

###### 1.1.2 Package Quality

Documents must be fully legible. Poor quality copies and material with hole punches obliterating the text or drawings will not be accepted.

###### 1.1.3 Package Content

Data package content must be as shown in the paragraph titled "Schedule of Operation and Maintenance Data Packages." For each product, system, or component piece of equipment requiring submission of O&M Data, submit the Data Package specified in the individual technical section.

###### 1.1.4 Delivery

Submit O&M Data Manuals to the Contracting Officer for review and acceptance; submit data specified for a given item within 30 calendar days after the item is delivered to the contract site.

- a. In the event the Contractor fails to deliver O&M Data/Manuals within the time limits set forth above, the Contracting Officer may withhold from progress payments 50 percent of the price of the item with which such O&M Data/Manuals are associated.

### 1.1.5 Changes to Submittals

Manufacturer-originated changes or revisions to submitted data must be furnished by the Contractor if a component of an item is so affected subsequent to acceptance of the O&M Data. Changes, additions, or revisions required by the Contracting Officer for final acceptance of submitted data, must be submitted by the Contractor within 30 calendar days of the notification of this change requirement.

## 1.2 TYPES OF INFORMATION REQUIRED IN O&M DATA PACKAGES

### 1.2.1 Operating Instructions

Include specific instructions, procedures, and illustrations for the following phases of operation:

#### 1.2.1.1 Safety Precautions

List personnel hazards and equipment or product safety precautions for all operating conditions.

#### 1.2.1.2 Operator Prestart

Include procedures required to set up and prepare each system for use.

#### 1.2.1.3 Startup, Shutdown, and Postshutdown Procedures

Provide narrative description for each operating procedure including control sequence for each.

#### 1.2.1.4 Normal Operations

Provide narrative description of normal operating procedures. Include control diagrams with data to explain operation and control of systems and specific equipment.

#### 1.2.1.5 Emergency Operations

Include emergency procedures for equipment malfunctions to permit a short period of continued operation or to shut down the equipment to prevent further damage to systems and equipment. Include emergency shutdown instructions for fire, explosion, spills, or other foreseeable contingencies. Provide guidance on emergency operations of all utility systems including valve locations and portions of systems controlled.

#### 1.2.1.6 Operator Service Requirements

Include instructions for services to be performed by the operator such as lubrication, adjustment, inspection, and gage reading recording.

#### 1.2.1.7 Environmental Conditions

Include a list of environmental conditions (temperature, humidity, and other relevant data) which are best suited for each product or piece of equipment and describe conditions under which equipment should not be allowed to run.

#### 1.2.2 Preventive Maintenance

Include the following information for preventive and scheduled maintenance to minimize corrective maintenance and repair.

##### 1.2.2.1 Lubrication Data

Include lubrication data, other than instructions for lubrication in accordance with paragraph titled "Operator Service Requirements":

- a. A table showing recommended lubricants for specific temperature ranges and applications;
- b. Charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities; and
- c. A lubrication schedule showing service interval frequency.

##### 1.2.2.2 Preventive Maintenance Plan and Schedule

Include manufacturer's schedule for routine preventive maintenance, inspections, tests and adjustments required to ensure proper and economical operation and to minimize corrective maintenance and repair. Provide manufacturer's projection of preventive maintenance work-hours on a daily, weekly, monthly, and annual basis including craft requirements by type of craft. For periodic calibrations, provide manufacturer's specified frequency and procedures for each separate operation.

#### 1.2.3 Corrective Maintenance (Repair)

Include manufacturer's recommendations on procedures and instructions for correcting problems and making repairs.

##### 1.2.3.1 Troubleshooting Guides and Diagnostic Techniques

Include step-by-step procedures to promptly isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or require replacement.

#### 1.2.3.2 Wiring Diagrams and Control Diagrams

Wiring diagrams and control diagrams must be point-to-point drawings of wiring and control circuits including factory-field interfaces. Provide a complete and accurate depiction of the actual job specific wiring and control work. On diagrams, number electrical and electronic wiring and pneumatic control tubing and the terminals for each type, identically to actual installation numbering.

#### 1.2.3.3 Maintenance and Repair Procedures

Include instructions and list tools required to restore product or equipment to proper condition or operating standards.

#### 1.2.3.4 Removal and Replacement Instructions

Include step-by-step procedures and list required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings and adjustments required. Instructions must include

a combination of text and illustrations.

#### 1.2.3.5 Spare Parts and Supply Lists

Include lists of spare parts and supplies required for maintenance and repair to ensure continued service or operation without unreasonable delays. Special consideration is required for facilities at remote locations. List spare parts and supplies that have a long lead time to obtain.

#### 1.2.4 Corrective Maintenance Work-Hours

Include manufacturer's projection of corrective maintenance work-hours including craft requirements by type of craft. Corrective maintenance that requires participation of the equipment manufacturer must be identified and tabulated separately.

#### 1.2.5 Appendices

Provide information required below and information not specified in the preceding paragraphs but pertinent to the maintenance or operation of the product or equipment. Include the following:

#### 1.2.6 Parts Identification

Provide identification and coverage for all parts of each component, assembly, subassembly, and accessory of the end items subject to replacement. Include special hardware requirements, such as requirement to use high-strength bolts and nuts. Identify parts by make, model, serial

number, and source of supply to allow reordering without further identification. Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate listing must show the index, reference, or key number which will cross-reference the illustrated part to the listed part. Parts shown in the listings must be grouped by components, assemblies, and subassemblies. Parts data may cover more than one model or series of equipment. components, assemblies, subassemblies, attachments, or accessories, such as a master parts catalog, in accordance with the manufacturer's standard commercial practice.

#### 1.2.6.1 Warranty Information

List and explain the various warranties and include the servicing and technical precautions prescribed by the manufacturers or contract documents to keep warranties in force. Include warranty information for primary components such as the compressor of air conditioning system.

#### 1.2.6.2 Personnel Training Requirements

Provide information available from the manufacturers to use in training designated personnel to operate and maintain the equipment and systems properly.

#### 1.2.6.3 Testing Equipment and Special Tool Information

Include information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components.

#### 1.2.6.4 Contractor Information

Provide a list that includes the name, address, and telephone number of the General Contractor and each subcontractor installing the product or equipment. Include local representatives and service organizations most convenient to the project site. Provide the name, address, and telephone number of the product or equipment manufacturers.

### 1.3 SCHEDULE OF OPERATION AND MAINTENANCE DATA PACKAGES

Furnish the O&M Data Packages specified in individual technical sections. The required information for each O&M Data Package is as follows:

#### 1.3.1 Data Package 1

- a. Safety precautions
- b. Maintenance and repair procedures
- c. Warranty information
- d. Contractor information

### 1.3.2 Data Package 2

- a. Safety precautions
- b. Normal operations
- c. Environmental conditions
- d. Lubrication data
- e. Preventive maintenance plan and schedule
- f. Maintenance and repair procedures
- g. Removal and replacement instructions
- h. Spare parts and supply list
- i. Parts identification
- j. Warranty information
- k. Contractor information

### 1.3.3 Data Package 3

- a. Safety precautions
- b. Normal operations
- c. Emergency operations
- d. Environmental conditions
- e. Lubrication data
- f. Preventive maintenance plan and schedule
- g. Troubleshooting guides and diagnostic techniques
- h. Wiring diagrams and control diagrams
- i. Maintenance and repair procedures
- j. Removal and replacement instructions



- k. Spare parts and supply list
- l. Parts identification
- m. Warranty information
- n. Testing equipment and special tool information
- o. Contractor information

#### 1.3.4 Data Package 4

- a. Safety precautions
- b. Operator prestart
- c. Startup, shutdown, and post shutdown procedures
- d. Normal operations
- e. Emergency operations
- f. Operator service requirements
- g. Environmental conditions
- h. Lubrication data
- i. Preventive maintenance plan and schedule
- j. Troubleshooting guides and diagnostic techniques
- k. Wiring diagrams and control diagrams
- l. Maintenance and repair procedures
- m. Removal and replacement instructions
- n. Spare parts and supply list
- o. Corrective maintenance man-hours
- p. Parts identification
- q. Warranty information

- r. Personnel training requirements
- s. Testing equipment and special tool information
- t. Contractor information

#### 1.3.5 Data Package 5

- a. Safety precautions
- b. Operator prestart
- c. Start-up, shutdown, and post shutdown procedures
- d. Normal operations
- e. Environmental conditions
- f. Preventive maintenance plan and schedule
- g. Troubleshooting guides and diagnostic techniques
- h. Wiring and control diagrams
- i. Maintenance and repair procedures
- j. Spare parts and supply list
- k. Testing equipments and special tools
- l. Warranty information
- m. Contractor information